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INVENTORY OF THE FAMILY CICADELLIDAE (HOMOPTERA) IN THE CULTURE OF THE POTATO (*SOLANUMTUBEROSUM* L) IN THE HIGHLANDS ALGERIANS

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ABSTRACT

An inventory study at two stations and for two years (2010-2011)in the highlands Algerians was performed on a culture of potato. The sampling method is that yellow sticky traps and yellow plates. In both study sites we found 12 species divided into three subfamilies: Eurymelinae (*Agallia constricta, Agallia quadripunctata*) Deltocephalinae (*Macrosteles fascifrons, Macrosteles borealis, Balcluthaabdominalis, Psammotettix alienus* and *Endria inimica*) and Typhlocybinae (*Typhlocyba pomaria* and *Empoasca fabae*). The largest gathering in the family is that of the Typhlocybinae is represented by the species Empoasca fabae, are more frequent in planting potato within two stations with 1038 individuals attracted to into the yellow plates and 1432 individuals trapped in the plates glued.

KEYWORDS: Cicadellidae, Potato, Yellow Sticky Traps, Yellow Traps, The Highlands Algerians (Djelfa)

INTRODUCTION

The potato (*Solanumtuberosum* L, *Solanaceae*) is an important food source in the world. Phytosanitary problems constitute one of the causes of limiting yields. Indeed potato has sensitive to many stress biotic (pests and diseases) and abiotic (climatic and physiological disease and stroke). These stresses affect both the aerial parts of the plant roots and tubers. These barriers related to damage caused by the various pests and diseases associated with this subservient and speculation. A study of the insect fauna of the Potato 2008, found that the most important is the family *Cicadellidae* with 41.1% of individuals, whose species belonging to this family proved to be very harmful in the planting of potatoes (Belatra, 2009). It contains a lot of pathogenic species that transmit plant diseases economically important.

Our objective, it is a biosystematics study of species of the family Cicadellidae existing in the culture of the potato. This study was conducted under field conditions on a variety *Desiree* potato with red skin in two stations in the highlands Algerians (Djelfa).

MATERIALS AND METHODS

Field Sites and Sampling Period

The leafhopper were surveyed in thehighlands Algerians, in the city of Djelf a pleasant medium-size city, north-central Algeria300 km south of Algiers (centralsteppe zone Algerians), during the season of summer when potato crops were available. We chose 2 sites in the region of Djelfa that represented the environmental conditions in which potato is planted. The high (>1,000 m) elevation sites included the Maâlba site (1144 m; 34° 40′ 00″ N 3° 15′ 00″ E) and the ITMAS site (Medium Agricultural Technological Institute Specialized In the same city. Samples were taken during 2 growing seasons in each site; May to Sep 2010 and May to Sep 2011. In both sites the same methodology was used to find and collects the leafhopper fauna.

Plant Material

The variety of potato *Solanumtuberosum* L. used in this study is Desiree, this late variety with large oblong tubers with red skin and yellow flesh (is amongst the most cultivated in Algeria), obtained in 1962 by crossing the variety Netherlands 'Urgenta' with the German variety 'Depesche', is characterized by different levels of resistance(Rousselle et *al*. 1996).

METHODOLOGY USED

- **Yellow Traps (Yellow Plates)**

They have a double attractiveness given firstly to their color, secondly to the presence of water, which is vital for insects (Benkhelil et *al*.1992). The principle of this method consists of a plastic container yellow, placed on the ground, half filled with water containing a detergent. In both stations, 4 color traps are placed at the four sides of the plot. Their implementation is weekly. After 24 hours the contents of each trap is filtered separately. Captured insects are collected in Petri dishes, bearing a label on which are mentioned indications of date and place of sampling. They are subsequently selected in the laboratory, we collected leafhoppers captured and put into vials containing of alcohol.

- **Yellow Sticky Traps**

They are derived from the paper " kill fly" on which is spread a sticky substance, they allow the identification, monitoring, and control of insect populations in crops. These plates are litters onto metal doors pikes information on the date and the name of the station, their location been in deferent locations in the plot. They are subsequently determined in the laboratory. Leafhoppers thus collected are put in small hermetic vials containing from alcohol70% .The identification of genera of leafhoppers collected within these stations based on the identification key described by GIUSTINA (1989).

- **Exploitation and Analysis of Results**

For the exploitation of our results, parameters and bio-ecological indexes are used in order to assess the quality of sampling, occurrence index, total wealth, the effectiveness of trapping methods, to evaluate the abundance and species dispersal.

RESULTS AND DISCUSSIONS

Systematic Inventory of the Family Cicadellidaeenfeoffedto the Potato

Analysis of the results revealed the presence of (12) species of leafhoppers divided into three subfamilies. Eurymelinae (*Agallia constricta* and *Agallia quadripunctata*) Deltocephalinae (*Macrosteles fascifrons, Macrosteles borealis, Balcluthaabdominalis Psammotettix alienus, Amplicephalus osborni, Deltocephalusflavocostatus*and *Endria inimica)* and Typhlocybinae *(Empoasca fabae* and *Typhlocyba pomaria).*

- **Colored Sticky Traps**

The analysis of results revealed the presence of (11) species of leafhoppers divided into 3 subfamilies.. Eurymelinae (*Agallia constricta*and*Agallia quadripunctata*), Deltocephalinae (*Macrosteles fascifrons, Macrosteles boréalis, Balcluthaabdominalis Psammotettix alienus, Amplicephalusosborni, Deltocephalusflavocostatus*and*Endria inimica*) andTyphlocybinae (*Typhlocyba pomaria*and*Empoasca fabae*) (Table 1).

The sampling device used in the two stations during the period from May 2010 to September 2010 and from May 2011 until September 2011. We helped develop a systematic list of species. This inventory is drawn up after consultation with several guides and keys: Gnaneswaran (2010); Zhniser JN. (2008); Giustina (2008); Dietrich (2005); Ribaut (1986); insect fauna of Quebec (1988- 2014). Some of the most relevant and inclusive over the last 60 years classifications are those of Evans (1947), Oman (1949), Linnavuori (1959) Metcalf (1967), Hamilton (1975) & AL Linnavuori NE'AMY (1983) and Oman et *al*, (1990). According to Evans (1947) classification was based principally on the morphology of the head and wings, and to some extent on the male genitalia.

Table 1: Global Taxonomic Leafhoppers Identified in the Yellow Sticky Plates

Sub Famille	Tribe	Genus	Species	Maâlba	ITMAS
Eurymelinae	Megophthalmini	Agallia	A. constricta (Van. Duze, 1894)	+	+
			A.quadripunctata(Provancher, 1872)	+	+
Typhlocybinae	Typhlocybini	Typhlocyba	T.pomaria (McAtee)	+	+
	Empoascini	Empoasca	E. fabae (Harris, 1841)	+	+
Deltocephalinae	Macrostelini	Macrosteles	M.quadrilineatus(Frobes, 1885)	+	+
			M.boréalis (Dorst, 1931)	+	+
		Balclutha	B.abdominalis(Van. Duze, 1892)	+	+
	Deltocephalini	Psammotettix	P.alienus (Dahlb, 1850)	+	+
		Amplicephalus	A.osborni (Van Duzee)	-	+
		Endria	E. inimica(Say 1830)	+	+
		Deltocephalus	D.flavocostatus(Van. Duze,1892)	-	+

In this report, we identified nine species belonging to three sub families the region Maâlba during 2011 while in the year 2010 we identified only seven species belonging to two sub-family.

- **Yellow Traps**

Analysis of the results revealed the presence of (10) species of leafhoppers divided into three subfamilies. Eurymelinae (*Agallia quadripunctata*) Deltocephalinae (*Macrosteles fascifrons, Macrosteles borealis, Psammotettix alienus, Amplicephalus osborni, Balcluthaabdominalis*and *Endria inimica*) and Typhlocybinae (*Empoasca fabae* and *Typhlocyba pomaria*). We note the absence of *Agallia constricta* agent yellow dwarf potatoes in all traps within the surveyed stations. We note the presence of a species that was not described in the yellow plates, belongs the sub family Deltocephalinae (*Limotettix anthracinus*).

The sampling device used in the two stations during the period from May 2010 to September 2010 and from May 2011 until September 2011. We helped develop a systematic list of the species. Systematic list of identified species established according to the taxonomic order of WILLIAM della GIUSTINA et *al*,. (2008), comprising 10 species belonging to the family Cicadellidae is reported in Table 2.

Table 2: Global Taxonomic Leafhoppers Identified in the Yellowtraps

Sub Famille	Tribe	Genus	Species	Maâlba	Itmas
Eurymelinae	Megophthalmini	Agallia	A.quadripunctata(Provancher, 1878)	+	+
Typhlocybinae	Typhlocybini	Typhlocyba	T.pomaria (McAtee, 1926)	+	+
	Empoascini	Empoasca	E. fabae (Harris, 1841)	+	+
Deltocephalinae	Macrostelini	Macrosteles	M. fascifrons (Frobes, 1885) ou . M.quadrilineatus	+	+
			M.boréalis (Dorst, 1931	+	+
		Balclutha	B.abdominalis (Van. Duze, 1892)	+	–
	Deltocephalini	Psammotettix	P.alienus (Dahlb, 1850)	+	+
		Amplicephalus	A.osborni (Van Duzee)	+	+
		Endria	E. inimica(Say 1830)	+	+
	Limotettigini	Limotettix	L.anthracinus(Van. Duze, 1894)	+	–

Comparison of Cicadellien Fauna Study Area between the Two Stations

The inventory cicadellien revealed the existence of nine species distributed in three different family in the area and Maâlba six species belonging to the same three subfamilies in the ITMAS station. According to the table 3, we find the importance of richness in the study area compared to the two years of monitoring, shows the richness of the year 2011 with a total of 1342 individuals has Maâlba and 530 in the station 'ITMAS. Wealth and the study Maâlba station compared to the other station. We note that the majority of the species are found in the presented Maâlba station.

Table 3: Comparison of Fauna Cicadellien récences Stuck in with Yellow Sticky Plates in Two Studies Stations

Study Zone Species	Maâlba		ITMAS	
	2010	2011	2010	2011
Agallia constricta	-	5	-	5
Agallia quadripunctata	-	1	-	1
Macrosteles fascifrons	11	84	4	17
Macrosteles boréalis	-	5	-	1
Balcluthaabdominalis	2	4	3	1
Psammotettix alienus	-	51	-	-
Amplicephalus osborni	9	-	-	1
Deltocephalusflavocostatus	-	1	2	-
Endria inimica	-	2	-	1
Typhlocyba pomaria	1	3	2	6
Empoasca fabae	127	1185	57	547
Total	**150**	**1342**	**68**	**580**

We note the absence *Agallia constricta*, *Agallia quadripunctata* and *Macrosteles borealis* in all plots surveyed during 2010 in both stations. The most common leafhopper is represented principally by *Empoasca fabae*; species most represented both effective as well as its dominance in all stations without exception, with relatively high numbers at the station Maâlba a total of 1185 individuals and 547 individuals in 2011 to the ITMAS.

The inventory of Cicadellien stand in yellow traps (Table 4), we note the absence of *Endria inimica, Typhlocyba pomaria* in all plots surveyed in the two stations. The most common herbivores are mainly represented by *Empoasca fabae* species most represented both effective as well as its dominance in two stations without exception, with relatively high numbers at the station Maâlba a total of 130 individuals harvested in 2010 and 289 individuals collected in 2011

Table 4: Comparison of Fauna Cicadellien récences Stuck in With the Yellow Traps in Two Studies Stations

Study Zone Species	Maâlba		ITMAS	
	2010	2011	2010	2011
Agallia constricta	-	6	1	4
Agallia quadripunctata	-	4	-	6
Macrosteles fascifrons	3	8	-	-
Macrosteles boréalis	-	-	4	-
Balcluthaabdominalis	-	15	21	12
Psammotettix alienus	3	32	-	72
Amplicephalus osborni	4	9	-	17
Deltocephalusflavocostatus	-	1	-	1
Endria inimica	-	-	-	-
Typhlocyba pomaria	-	-	-	-
Empoasca fabae	130	289	19	281
Limotettix anthracinus	1	26	1	11
Total	141	390	46	404

Trapping Efficiency

In order to demonstrate the efficiency of the two types of traps used in our study, namely, sticky traps and water traps (yellow tub); we calculated the percentages of catches by two methods (Table 5).

Table 5: Percentage of Leafhoppers Captured in the Two Study Regions According to the Type of Trapping

Regions	Maâlba				Itmas			
	2011		2010		2011		2010	
Traps	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Colored sticky traps	1342	77.48	150	51.55	547	57.52	68	59.65
Yellow Traps	390	22.52	141	48.45	404	42.48	46	40.35
Total	1732	100	291	100	951	100	114	100

The majority of the specimens collected leafhoppers are captured on the glued areas for the two plates. Are effective in the capture, this will return to its height is equivalent to the air part of the plant and its yellow coloration. And also prove quite effective because of its adhesive that make the impossibility of escape.

Structure Parameters and Organization Stands Leafhoppers Identified

- **The Sampling Quality**

  This index is represented by a / N where: a: Number of observed species once. N: Number of readings.

In this case on all 20 records in the two stations, a species has been observed (collected) one time. Therefore the quotient a / N = 1/20 shows that our sampling is very satisfactory. The only species recorded only once during the 20 outputs is the number one. This is *Agallia quadripunctata* caught Maâlba but with 1 exemplary.

- **Stational Distribution and Similarity of Leafhopper Species Identified**

During the sampling of each species, we found the exact stations where they were collected and we calculated the percentage of each species (Table 6), the occurrence of different species in tow stations surveyed frequencies. The results obtained are listed in Table 7.

Table 6: Percentage of Leafhopper Species Identified on the Two Stations (SP: Sticky Plate, YT: Yellow Traps)

Région	Maâlba				ITMAS				Total			
Species	**SP**	**YT**	**Tot**	**%**	**SP**	**YT**	**Total**	**%**	**SP**	**YT**	**Tot**	**%**
A. constricta	5	6	11	0.57	5	5	10	0.90	10	11	21	0.69
A.quadripunctata	1	4	5	0.26	1	6	7	0.63	2	10	12	0.39
M.fascifrons	95	11	106	5.48	21	-	21	1.90	116	11	127	4.18
M. boréalis	5	-	5	0.26	1	4	5	0.45	6	4	10	0.33
B.abdominalis	4	15	19	0.98	4	12	16	1.45	8	27	35	1.15
P. alienus	53	35	88	4.55	-	93	93	8.40	53	128	181	5.95
A.osborni	0	13	13	0.67	10	17	27	2.44	10	30	40	1.32
D. flavocostatus	1	1	2	0.10	2	1	3	0.27	3	2	5	0.16
E. inimica	2	-	2	0.10	1	-	1	0.09	3	-	3	0.10
T.pomaria	4	-	4	0.21	8	-	8	0.72	12	-	12	0.39
E.fabae	1231	419	1650	85.36	604	300	904	81.66	1835	719	2554	84.01
L.anthracinus	-	27	27	1.40	-	12	12	1.08	0	39	39.00	1.28
Total	**1402**	**531**	**1933**	**100**	**657**	**450**	**1107**	**100**	**2059**	**981**	**3040**	**100.00**

Table 7: Stational Distribution and Frequency of Occurrence of the Identified Species in the Two Stations (-: Absence of Species, +: Presence of Species)

Stations	Maâlba				ITMAS				C%	Scale
Pièges	**Sticky plate**		**Yellow Traps**		**Sticky plate**		**Yellow Traps**			
Spècies	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**		
A. constricta	-	+	-	+	-	+	+	+	62.5	C
A.quadripunctata	-	+	-	+	-	+	-	+	50	C
M. fascifrons	+	+	+	+	+	+	-	-	75	C
M.boréalis	-	+	-	+	-	-	+	-	37.5	A
B.abdominalis	+	+	-	+	+	+	+	+	87.5	C
P.alienus	+	+	+	+	-	-	-	+	62.5	C
A.osborni	-	-	+	+	-	+	-	+	50	C
D.flavocostatus	-	+	-	+	-	-	-	+	37.5	A
E.inimica	-	+	-	-	-	+	-	-	25	A
T.pomaria	+	+	-	-	+	+	-	-	50	C
E.fabae	+	+	+	+	+	+	+	+	100	C
L.anthracinus	0	-	+	+	-	-	+	+	50	C
Number of species	5	10	5	10	4	8	5	8		

{C (%): Frequency of occurrence; A: accessory; C: constant}.

The majority of the species recorded constant values greater than 50% consistency and, therefore, have a ubiquitous space (explored stations).

- **Diversity and Equal Distribution**

Order to evaluate the composition of the population and cicadellien steady populations that comprise state, we calculated the total species richness, diversity index and equitability SHANNON following years of study and stations

prospected (Table 8). We also calculated the same parameters for both types of trap used (Table 9).

Table 8: Total Wealth (S), Diversity Index SHANNON (H ') and Equal Distribution (E) Stands Cicadelliens by Years of Follow-Up

Station Indice	Maâlba		ITMAS	
	2010	2011	2010	2011
Richesse totale S	6	12	8	12
H' (bits)	0.34	0.96	1.1	1.03
H'max (bits)	2.58	3.58	2.4	3.58
Équirépartition E	0.13	0.26	0.36	0.28

The recorded values show that the numbers of different species present in equilibrium with each other. The fairness it tends to 0 when almost all of the workforce is concentrated on one species.

Table 9: Total Wealth (S), Diversity Index SHANNON (H ') and Equidistribution (E) Stands Cicadelliens following the Two Types of Trapping

Traps / Indices	Sticky Plate	Yellow Traps
Total wealth S	11	10
H' (bits)	0.70	1.48
H'max (bits)	3.4	3.32
Équirépartition E	0.20	0.44

About the type of trapping, trapping both types are listed with almost the same total wealth (11 and 10 species). We recall that *Endria inimica* and *Typhlocyba pomaria* have been captured only once through the trap sticky traps while *Limotettix anthracinus* were caught in yellow bowls. The index values range from 0.70 Shannon bit for bit sticky traps at 1.48 for yellow bedpan. There is a slight variation of the index equal distribution between the two types of trapping.

CONCLUSIONS

This study was conducted primarily in the province of Djelfa, this study mainly devoted to the study of the diversity of leafhoppers subservient in the culture of potatoes in various fields. From May to September 2010 and from April to August 2011, a total of 3090 is collected leafhoppers which were identified to species. The inventory tracking leafhoppers on two stations in the highlands of Algeria has revealed the existence of 12 major species, made from plant-represented mainly by *Agallia constricta, Agallia quadripunctata, Macrosteles fascifrons, Macrosteles borealis, Balcluthaabdominalis, Psammotettix alienus, Amplicephalus osborni, Deltocephalusflavocostatus, Endria inimica, Typhlocyba pomaria, Empoasca fabae* and *Limotettix anthracinus.* Total wealth varies between 6-12 species. The highest value recorded in the stations in 2011, with 12 species. Densities of leafhoppers caught are greater on bogged plates, but species richness is the same for both types of entrapments (10 and 11 for each type). Cicadellienne the wildlife station Maâlba is more diverse. Indeed, the maximum value of diversity is observed at 3.58 bits Maâlba.

Perspectives in the study of population fluctuations leafhoppers is possible with inventory tracking parasitoids remains desirable to compile a list of potential predators and to avoid misuse of pesticide treatments that destroy the auxiliary fauna useful to preserve our biodiversity for a sustainable culture.

In North Africa, cicadellienne wildlife is not sufficiently known both in terms of biodiversity and in terms of the specific biology. It would be interesting in the future to shed light on the ecological characteristics of the different species

to observe the migration of leafhoppers in their natural habitats.

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